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Rept. on the resistance  
and tolerance of corn  
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by L.E. Patch.....  
Mar. 1935.

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REPORT ON THE RESISTANCE AND TOLERANCE OF CORN VARIETIES  
TESTED IN 1934

Division of Cereal and Forage Insects  
Bureau of Entomology and Plant Quarantine  
U. S. Department of Agriculture

European Corn Borer Research





## REPORT ON THE RESISTANCE AND TOLERANCE OF CORN VARIETIES TESTED IN 1934.

L. H. Patch, Associate Entomologist, and G. T. Bottger, Junior Entomologist, Division of Cereal and Forage Insects, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

The data given in this report were obtained in connection with research on the European corn borer conducted from the laboratory at Toledo, Ohio, W. A. Baker, in charge. Various federal and state agencies and individual seedmen cooperated by providing the corn seed. Messrs. J. R. Holbert, R. R. St. John, and Merle T. Jenkins of the Division of Cereal Crops and Diseases, U.S. Bureau of Plant Industry, and Mr. G. H. Stringfield of the Ohio Agricultural Experiment Station provided seed of most of the corn strains.

The experiment was started in 1930. The results of the work previous to 1934 have been assembled in an unpublished manuscript. The agronomic phases of the corn varieties tested in 1934 have been given in a mimeographed report and distributed to the various cooperators. Some of the data in the present report were taken from that manuscript. In 1934, the work was conducted on a 3.6-acre field divided into 288 plots, each 2 by 18 hills in size. One third of these plots was planted on each of 3 dates, May 3, May 17, and May 31. Eighteen top crosses, single crosses, double crosses, and open-pollinated varieties were planted on each of the three dates, and in addition to these, six strains were planted on May 3, six on May 17, and six on May 31. The experiment was laid out in four-fold replication. The varietal sequence within the four replications of each planting was at random. Sixteen hills of each plot were subject to natural infestation by the European corn borer moths, and sixteen hills were infested by hand with an average of 84 eggs per plant. The remaining four hills acted as a buffer between the two types of infestation. The mean number of mature borers per infested and non-infested plants of all strains naturally infested, was 1.43, 0.97, and 0.41 for the three plantings, respectively. These borers resulted from moths that laid 6.8, 6.6, and 3.9 eggs per plant on the three plantings, respectively. The mean percentage of borer survival was, therefore, 21.0, 14.7, and 10.5, on the three plantings, respectively.

The mean number of mature borers per plant resulting from the eggs placed on the plants by hand, plus those laid by the moths in nature, was 8.99, 6.26, and 4.23 for the three plantings, respectively. The mean percentage of borer survival on these plants was 9.90, 6.91, and 4.95, on the three plantings, respectively.

### The Relative Resistance of Corn Strains to Borer Survival

Previous work has shown conclusively that the non-availability of corn tassels, at the time the borer eggs are hatching, results in increased mortality of the young borers. The tassels are made partially or wholly unavailable in 3 ways: by planting strains having longer seasonal requirements so that the plants will tassel later, by planting later, or by the use of strains which keep the upper leaves of the plant tightly enclosing the tassel until it is nearly ready to shed pollen.



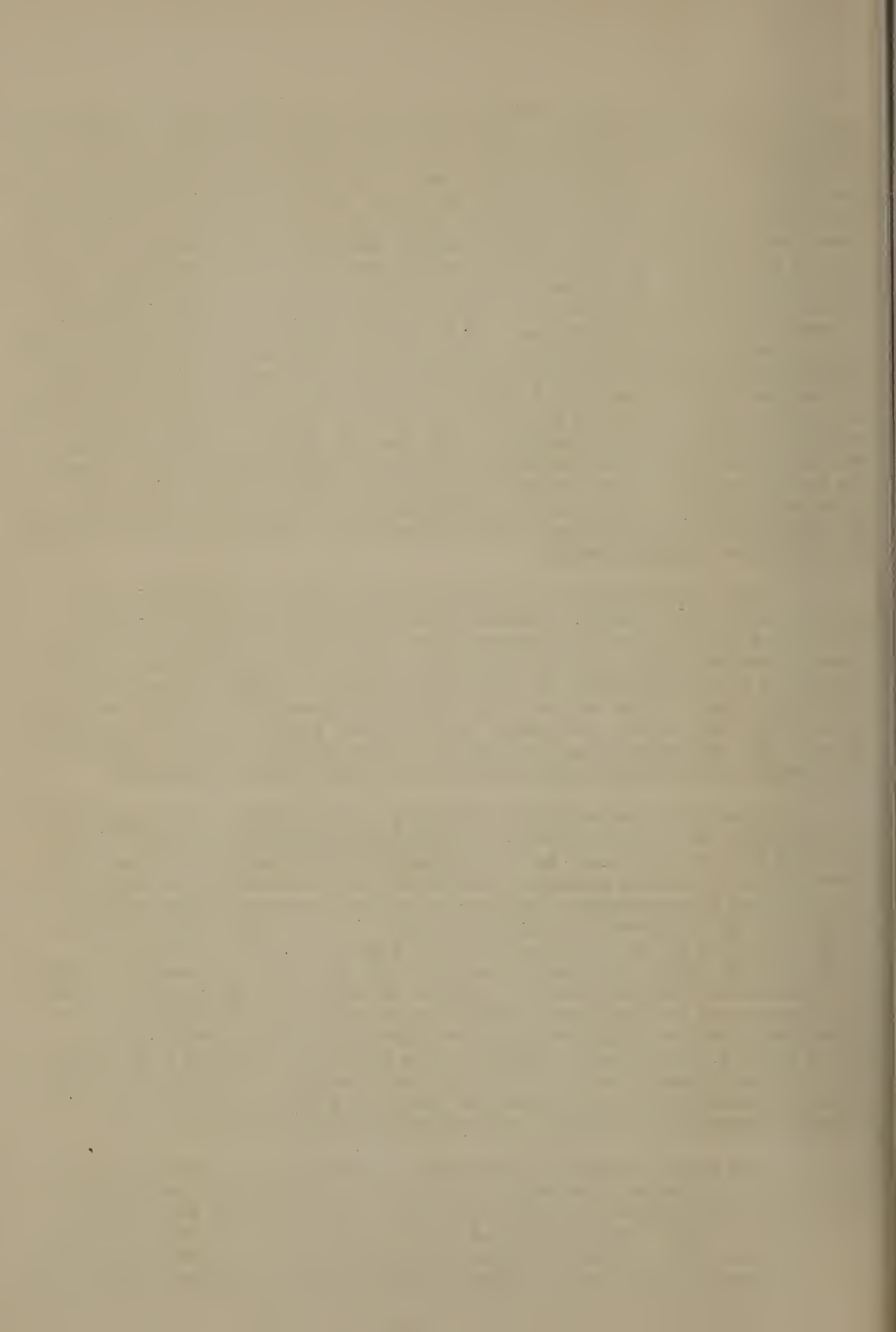


The use of strains possessing the late tassel emergence characteristic seems to promise the greatest possibilities of reducing the survival rate of the young borers. Our experiments have shown that by growing these strains, injury by the corn borer was reduced without materially prolonging the seasonal term of growth for the corn. This advantage held good for all dates of planting used. During 1934, at the time of tasseling, record was made of all the strains that showed any indication of the delayed tassel emergence characteristic and of the strains that were most advanced in tasseling and with their tassels most available to the borers. On certain dates, record was made of the percentage of plants of these same strains that showed as much as, or more than, the tip of the main spike of their tassels. For the May 3 planting 9 strains of the first group averaged 7.14 mature borers per plant with 56.0 percent of their plants showing their tassels on July 11 and 6 strains of the second group averaged 8.96 borers per plant with 90.3 percent of their plants showing their tassels on July 11. For the May 17 planting 7 strains of the first group averaged 4.83 borers per plant with 53.1 percent of the tassels showing on July 17, and 4 strains of the second group averaged 6.92 borers per plant with 90.6 percent of the tassels showing. For the May 31 planting 7 strains of the first group averaged 2.67 borers per plant with 78.9 percent of the tassels showing on July 27, and 4 strains of the second group averaged 4.31 borers per plant with 94.9 percent of the tassels showing.

The strains having the delayed tassel emergence characteristic averaged 20.3, 30.2, and 38.1 percent fewer borers per plant on the May 3, May 17, and May 31 plantings, respectively, than did the strains with their tassels most available to the young borers. The seasonal requirements of the strains up to the appearance of the silks averaged 1.4 days longer for the first group than for the second. The degree of association between the mature borers per plant and the percentage of the plants showing tassels on certain dates of the different strains of both groups as expressed by the coefficient of correlation was highly significant for all three dates of planting.

The single cross hybrids involving inbred R<sup>4</sup> have been consistently most resistant to the corn borer, and hybrid Hy X R<sup>4</sup> most resistant of all. Hybrid Hy X R<sup>4</sup> is considered by the agronomists to be superior in yield and several other desirable agronomic qualities. The accompanying photographs show, 61 days after planting, the type of tassel emergence characteristic of hybrid Hy X R<sup>4</sup> in contrast to hybrid A X TR, or other single cross hybrids involving inbred A. The innermost topmost leaves of one of the plants of hybrid Hy X R<sup>4</sup> (upper photograph) are bent back to expose the enclosed tassel. It is noticeable that although the tassels of hybrid A X TR are only slightly further advanced in development than those of hybrid Hy X R<sup>4</sup> the leaves have fallen away from the tassel exposing the tassel buds to the young borers, within which a greater number survive. The tassels of hybrid A X TR emerged in the ordinary manner common to all the local varieties so far tested. The partial availability of the tassels of hybrid Hy X R<sup>4</sup>, on the other hand, is a decided advantage in reducing the numbers of borers surviving.

The results obtained in 1934 were consistent with those of previous years, as those strains previously noted as being infested by fewer mature borers, per given number of eggs, were found to be relatively resistant to the borer this year. On the basis of investigations prior to 1934, it was predicted that 30 to 35 percent fewer borers would survive to maturity on the strains possessing the tassel emergence characteristic of single cross Hy X R<sup>4</sup>,







Single cross hybrid Hy X R<sub>4</sub>.



Single cross hybrid A X TR.





if the eggs could be placed by hand on the plants early enough so that their hatching would more nearly coincide with the mean date of hatching of the eggs laid by the moths in nature. Both the weather in May and June, and the conditions of work conspired in 1934 to make this objective possible, the mean date of hatching of the eggs placed on the plants by hand and by the moths in nature being July 8 and July 6, respectively. As a result, hybrid Hy X R<sup>4</sup> this year averaged 35.4 percent less borers from a given number of eggs than the most susceptible local varieties, Woodburn and Clarage, and the susceptible hybrids A X TR, WF9 X Krug, and (Ax90) X Hy. The seasonal requirements for plant growth as measured by the mid-silking date averaged only one day longer for hybrid Hy X R<sup>4</sup> than for the susceptible strains. For the different dates of planting, the reduction in borer survival on hybrid Hy X R<sup>4</sup> was 22.3, 31.6, and 52.2 percent for the May 3, May 17, and May 31 plantings, respectively.

The mean number of mature borers per plant resulting from a mean of 89.8 eggs per plant hatching on the three plantings is given in Table 1 for each of the 18 strains planted on all three dates. Each value is based on a sample of 120 plants, 10 plants from each of the four replications from each of the three plantings.

Table 1. - Mean Number of Mature Borers per Plant Surviving from 89.8 Eggs per Plant for Different Strains Planted in 1934 at Toledo, Ohio.  
(Mean of all Three Plantings)

Field Number of Strain	Pedigree	Borers per Plant	Generalized Standard Error
14	Ill. Hy X R <sup>4</sup>	4.57 )	.276
2	Ia. L317B2 X Krug	4.66 )	
12	Ill. (HyxR <sup>4</sup> ) X (Ill. AxB.P.I. 540)	4.73 )	
1	Ill. R <sup>4</sup> X Krug	4.94 )	.286
13	(Ind. 66xIll. R <sup>4</sup> ) X Ind. TR	5.02 )	
8	(L317B2xB1 349A) X (B1. 345BxMC 401A1)	5.10 )	
10	Ill. (AxHy) X (Ind. TR x Ia. L317B2)	5.47 )	.306
5	Ill. A X Krug	5.54 )	
11	(Ill. LxInd. 66) X Ind. TR	5.56 )	
4	Ind. TR X Krug	5.64 )	.313
7	ITE 701 X Krug	5.67 )	
9	Krug	5.92 )	
6	Ill. Hy X Krug	5.93 )	.329
16	Ill. (Ax90) X Ill. Hy	6.16 )	
18	Johnson's Clarage	6.67 )	
15	Ill. A X Ind. TR	6.75 )	.353
17	Mast's Woodburn	6.77 )	
3	Ind. WF9 X Krug	7.08 )	

In addition, there is given in Table 2 the pedigree and the borer population of the strains planted on one date in comparison with the mean borer population of the 5 most resistant and 5 most susceptible strains of the respective plantings. The comparisons are made with strains Hy X R<sup>4</sup>, R<sup>4</sup> X Krug, L317B2 X Krug, (66xR<sup>4</sup>) X TR, and (HyxR<sup>4</sup>) X (Ax540) as the most resistant strains and with strains A X TR, WF9 X Krug, (Ax90) X Hy, Clarage, and Woodburn as the most susceptible strains.





Table 2. - Continuation of Data Given in Table 1 for those Strains Planted on One Date.

Field Number of Strain	Pedigree	Borers per Plant	Generalized Standard Error
Planted May 3, 1934			
	Mean of 5 most resistant strains	7.00	.232
20	(Ind. TRxIll. R <sup>4</sup> ) X Ill. (AxHy)	6.73)	
24	Ind. TR X Ill. R <sup>4</sup>	6.95)	.533
21	Ill. Hy X Ind. TR	<u>7.23)</u>	
22	(OS 420 x OS 426)X (L289 x I 234)	7.48)	
19	(Ind. WF9 x Ill. R <sup>4</sup> ) X Ill. (AxHy)	8.18)	.608
23	Iowa Hybrid 939	<u>9.33)</u>	
	Mean of 5 most susceptible strains	9.08	.277
Planted May 17			
	Mean of 5 most resistant strains	4.75	.232
26	Ohio C 920 X 3200 G	4.85)	
29	Ohio 356 A. X 584 E	5.03)	.528
30	Synthetic Variety-Marston	<u>5.10)</u>	
25	Ohio 3201 E X Woodburn	6.05)	
27	(Conn. 1-6xOhio C920) X (B.P. I. 540xIll. A)	6.25)	.643
28	Ohio(584Ex228-4-8)X Ohio(3173Bx3201E)	<u>6.95)</u>	
	Mean of 5 most susceptible strains	6.85	.300
Planted May 31			
	Mean of 5 most resistant strains	2.61	.149
35	Ill. (K x R <sup>4</sup> ) X Ind. (66 x TR)	2.58)	
33	Ill. (Hy x R <sup>4</sup> ) X (Ia. L317 x Bl. 351A)	2.75)	.341
34	(Ind. WF9xIll. Hy) X Ind. (66 x TR)	<u>2.95)</u>	
31	Ill. (HyxR <sup>4</sup> ) X Ind. (66 x TR)	3.18)	
26	Ohio C 920 X 3200 G	3.72)	.404
32	Ill. 90 X Krug	<u>3.78)</u>	
	Mean of 5 most susceptible strains	4.14	.200



From a study of Table 1 it may be observed that four of the five most resistant strains contain inbred R<sup>4</sup> in their pedigree. The fifth strain is L 317B2 X Krug. Inbred L 317B2 possesses the desired tassel emergence characteristic of inbred R<sup>4</sup> and no doubt this is the cause of the relatively low survival on it. The Iowa strain (L 317B2 x B1 349A) X (B1.345B x MC401A1), also known as Iowa hybrid No. 13, has been a consistently high yielder since first tested in 1932 in Northern Ohio. The borer survival has also been relatively lower on it in each test. This strain has distinct possibilities under corn borer conditions.

By referring to Table 2 it is noted that strains (TRxR<sup>4</sup>) X (AxHy) and TR X R<sup>4</sup> of the May 3 planting are comparable in borer survival with the five most resistant strains, and here again inbred R<sup>4</sup> enters into the pedigrees.

The Ohio strain 356A X 584E of the May 17 planting appears to possess possibilities of being of use as a resistant strain. A note was made at the time of tasseling that it possessed a pronounced tassel emergence characteristic. This strain ranked third in yield, lodged very little, had no smut, few broken plants and rotted ears but, on the other hand, most all of the ear tips were bare, which character was undesirable.

The Ohio strain C920 X 3200 G of the May 17 planting was also relatively low in borer survival. A field note was made that this strain did not possess a tassel emergence characteristic of the "R<sup>4</sup>" type. Since this strain had a high percentage of its plants showing tassels on July 17, 95.0 compared with the 25.6 percent of hybrid Hy x R<sup>4</sup>, the reason for its low borer survival is not known. This strain should be given further tests.

Strains (KxR<sup>4</sup>)X(66xTR) and (HyxR<sup>4</sup>)X(L317xB1.351), of the May 31 planting, are comparable in borer survival with the five most resistant strains, and inbred R<sup>4</sup> enters into the pedigree of these strains, also. Double cross (HyxR<sup>4</sup>)X(L317xB1.351A) was the outstanding yielder of the entire lot and in addition the borer survival on it was 33.6 percent less than the mean borer survival on the five most susceptible strains of the same planting. The Indiana strains (WF9 x Hy) X (66xTR) and (Hy x R<sup>4</sup>) X (66xTR) of the May 31 planting are noteworthy for their high yields and low borer survivals.

In a supplementary experiment small plots of Maize Amargo and seven other strains of corn provided by Mr. A. R. Marston of the Michigan Agricultural Experiment Station were compared with hybrid Ill. Hy x R<sup>4</sup> for their resistance to the corn borer. From 30 to 55 plants of each strain were available for the purpose and all were infested by hand with nearly an equal number of eggs per plant on July 13. On July 16 record was made of the percent of the plants showing tassels and on July 24 all the plants were dissected for the number of borers resulting. The data appear in Table 3.





Table 3. - Relative Resistance to the Corn Borer of Certain Strains from the Michigan Agricultural Experiment Station Planted in Supplementary Plots near Toledo, Ohio, 1934.

Pedigree	Number of Plants	Borers per Plant	Percent of Plants Showing Tassels
Mich. B.R. 275F <sub>2</sub> Syn. Hybrid Pure Maize Amargo Ill. Hy x R <sup>4</sup> (Standard for comparison)	49	2.61	13
Mich. B.R. 30 F <sub>8</sub>	44	5.18	89
" B.R. 67 F <sub>8</sub>	44	6.64	87
" B.R. 549F <sub>6</sub>	43	6.69	67
" B.R. 31 F <sub>8</sub>	31	6.74	100
" B.R. 1173 F <sub>5</sub>	34	7.88	56
" B.R. 10 F <sub>8</sub>	30	9.67	10
" B.R. 57 F <sub>8</sub>	53	9.67	68

Mich. Synthetic Hybrid 10 F<sub>2</sub> was not planted in the supplementary experiment but enough seed of it was available to test in the May 17 planting of the major experiment. The mean number of borers per plant in it was 5.10 compared with 4.68 borers in hybrid Hy x R<sup>4</sup>, the standard of comparison. On July 17, 52.6 percent of the tassels of No. 10 F<sub>2</sub> were showing compared with 25.6 percent of hybrid Hy X R<sup>4</sup>. No. 10 F<sub>2</sub> was not observed to possess the type of tassel emergence possessed by hybrid Hy X R<sup>4</sup>.

#### Increased Yields Gained by Planting Strains of Corn Resistant to the Corn Borer

It is recognized by the agronomists that the commercial production of hybrid corn seed requires double cross hybrids. Accordingly, the most productive, most resistant double crosses were selected, from the 1934 data, with which to estimate the increased yield because of their borer resistance. These estimates are made on the basis of the smaller number of borers reaching maturity from a given number of eggs, and the calculated reduction in yield per borer per plant.

Planting the resistant double cross (Hy x R<sup>4</sup>) X (A x 540) gave an increase in yield of 5.0, 5.6, and 2.6 bushels per acre on the May 3, May 17, and May 31 plantings, respectively, due to 2.98, 1.70, and 1.19 less borers per plant compared with the 5 most susceptible hybrids and local varieties, A X TR, WF9 X Krug, (A x 90) X Hy., Clarage, and Woodburn. In addition to these estimated increases in yield due to fewer borers there is the increase in yield due to the inherent yielding ability of the hybrids compared with the local open-pollinated varieties. The yield of hybrid (Hy x R<sup>4</sup>) X (A x 540) in the absence of corn borers was estimated to average 91.1 bushels per acre from the 3 plantings compared with 66.3 and 68.6 bushels from the 2 local varieties.





The May 31 planting of the resistant double cross (Hy x R<sup>4</sup>) X (L317B2 x B1.351A) gave an increase in yield of 7.6 bushels per acre due to 1.39 less borers per plant reaching maturity from a given number of eggs. The yield of this strain in the absence of corn borers was estimated to be 110.6 bushels per acre compared with 64.4 and 68.7 bushels from the 2 local varieties. Comparable data are not available for the other plantings.

Planting the resistant double cross (L317B2 x B1.349A) X (B1.345B x MC401A1) gave an increase in yield of 4.1, 9.8, and 5.5 bushels per acre on the May 3, May 17, and May 31 plantings, respectively, due to 1.70, 1.82, and 1.24 less borers per plant. The yield of this strain in the absence of corn borers was estimated to average 100.5 bushels per acre for the three plantings compared with 66.3 and 68.6 bushels from the 2 local varieties.

The May 3 planting of the resistant double cross (TR x R<sup>4</sup>) X (A x Hy) gave an increase in yield of 4.4 bushels per acre due to 2.35 less borers per plant. The yield of this strain in the absence of corn borers was estimated to be 89.3 bushels per acre compared with 62.9 and 68.4 bushels from the 2 local varieties. Comparable data are not available for the other plantings.

The May 31 planting of the resistant double cross (K x R<sup>4</sup>) X (66 x TR) gave an increase in yield of 4.6 bushels per acre due to 1.56 less borers per plant. The yield of this strain in the absence of corn borers was estimated to be 90.5 bushels per acre compared with 64.4 and 68.7 bushels from the 2 local varieties. Comparable data are not available for the other plantings.

The three comparisons available from the May 3 planting, the two from the May 17 planting, and the four from the May 31 planting, give average increases in yield, due to 2.34, 1.76, and 1.35 less borers reaching maturity from a given number of eggs, of 4.5, 7.7, and 5.1 bushels per acre respectively. Compared with these values the most resistant of all hybrids so far tested, single cross Hy X R<sup>4</sup>, gave an increase in yield of 4.0, 8.0, and 8.3 bushels per acre on the May 3, May 17 and May 31 plantings, respectively, due to 2.03, 2.17, and 2.16 fewer borers per plant compared with the 5 most susceptible hybrids and local varieties mentioned previously. These comparisons are for one year and are based on few strains. It is believed on the basis of previous work that for a period of years the differences in the increases in yields on the different plantings between hybrid Hy X R<sup>4</sup> and double crosses not so resistant as hybrid Hy X R<sup>4</sup> would be greater than the above values indicate, and that, as between hybrid Hy X R<sup>4</sup> and double crosses as resistant as hybrid Hy X R<sup>4</sup>, the differences would be still greater. An objective of this cooperative work is to breed double crosses having the "R<sup>4</sup>" type of tassel emergence to as great a degree as hybrid Hy X R<sup>4</sup>. To further this project the various inbreds growing on the plots of J. R. Holbert, Bloomington, Illinois, were examined for the "R<sup>4</sup>" type of tassel emergence at the time of tasseling in 1934. As many as 7 promising inbreds were selected and, with the use of these, 21 new single cross combinations were made. These crosses are available for testing their agronomic qualities and degree of "R<sup>4</sup>" tassel emergence characteristic the coming season, and to observe any other plant characteristic inhibiting the survival of the borer that may become evident.





### The Tolerance of Strains of Corn to the Corn Borer

There have been indications that some strains will yield proportionately more under equal levels of corn borer populations than will other strains when the estimated yields of the strains in the absence of corn borers are considered. Stated in another way, as one special case, if two strains yielded the same in the absence of corn borers, under conditions of equal borer infestations the tolerant strain would be expected to yield more than the other. During the progress of the work one very desirable single cross hybrid, A X TR, has been consistently tolerant. In judging the tolerance of strains, it is necessary to take into consideration the level of yield of the strains compared, because tolerance is measured by the relative amount of reduction in yield per acre per borer per plant, and this value increases within a planting with an increase in the level of yield. For example, in the 1934 experiment, six strains averaged 96.9 bushels per acre in the absence of borers and the yield with borers present was reduced at the rate of 3.770 bushels per acre per borer per plant. A comparable value for 6 strains yielding 92.1 bushels is 3.491, and for 6 strains yielding 78.7 bushels is 3.149. The differences between these three values this year are not great because of the narrow range in the yield of different strains in the absence of borers. However, the yield of hybrid A X TR in the absence of borers was 98.1 bushels and, on the basis of the above data, the reduction in yield of this strain with borers present would be expected to be about 3.77 bushels per acre per borer per plant. However, the actual value was calculated to be 2.34, a difference of about 1.43 bushels per acre per borer per plant.

Hybrid A X TR is the only strain of agronomic importance that is known to possess a degree of tolerance to the borer. In six out of seven tests its tolerance has been appreciable. In each test it has ranked high in estimated yields in the absence of borers. Its tolerance is probably associated in some way with its vigor. Sections of stalks were preserved for studying the relative number of tracheae per unit cross section of different strains but a report on this is not available at this time. The gain in yield due to the tolerance of strains would be especially worthwhile under conditions of severe corn borer infestation, but under conditions of moderate infestation their use would hardly be justified on the basis of their tolerance alone.

The 1934 results showed that strains planted on a late or later than normal date are less tolerant to the borer than the same strains planted earlier. The mean reduction in yield of 18 strains planted on May 3, May 17, and May 31, was 2.29, 3.57, and 4.54 bushels per acre per borer per plant, respectively. This is in accordance with previous experience. Although about half as many borers reached maturity from a given number of eggs on the May 31 planting as compared with the May 3 planting, the borers on the late planting did twice as much damage per borer, thus offsetting the possible gain by having fewer borers in the late planting.

It is possible that the greater tolerance of strains planted on an early date, compared with the same strains planted on a later date, is associated with the shorter time the borers have in which to feed before the ear commences to develop (silking date). In the early planting, the ears would have reached a more advanced stage of development than in the later planting when the borers had advanced enough in their development to do the maximum amount of damage to the





plants. The number of days from the hatching of the eggs placed on the plants to the silking of the plants was 10.5, 16.7, and 24.7 for the May 3, May 17, and May 31, 1934, plantings, respectively. These values are in the ratios as 1 is to 1.59, is to 2.35. The mean reductions in yield per acre per borer per plant of the 18 strains planted on the three dates are in the ratios as 1 is to 1.56, is to 1.98. The close similarity of these ratios with those giving the number of days between borer hatching and plant silking is suggestive of some relation between the development of the ear and the borer and the resultant damage to the plant. If such a relation does exist it is far from being constant from year to year. In 1933 the interval between egg hatching and plant silking was 10.8 and 17.8 days for the May 19 and June 2 plantings, respectively, whereas the reduction in yield per acre per borer per plant was 2.857 and 2.976 bushels for the two plantings, respectively. The growing conditions for early growth of the June 2 planting were better than for the May 19 planting in 1933, whereas in 1934, the average growth conditions of the three plantings were believed to be very similar. This belief is substantiated by the fact that differences of 14 and 28 days in the planting of the May 17 and May 31 plantings compared with the May 3 planting caused differences of 8 and 16 days in the silking. It is possible that the relative plant vigor or growth conditions between plantings may be a contributing factor in the relative amount of damage caused by the borer to different plantings of different years.

The reduction in yield in bushels per acre per borer per plant ("b" value) and the estimated yield in the absence of borers ("a" value) are given in Table 4 for the different strains. Only the field numbers of the strains are given. The pedigrees are found in Tables 1 and 2 corresponding to the field numbers in Table 4.





Table 4. - Reduction in Yield in Bushels per Acre per European Corn Borer per Plant ("b" value) and Estimated Yield in the Absence of Borers ("a" value) for Different Strains near Toledo, Ohio, 1934.

May 3 Planting				May 17 Planting				May 31 Planting			
Field No.	"a"	"b"	S.D. of "b"	Field No.	"a"	"b"	S.D. of "b"	Field No.	"a"	"b"	S.D. of "b"
Strain	Value	Value	"b"Value	Strain	Value	Value	"b"Value	Strain	Value	Value	"b"Value
15	104.0	2.75	.472	8	110.8	5.41	.836	33	114.4	6.37	1.535
21	101.9	2.87	.629	29	104.9	2.65	.855	10	105.3	5.46	1.487
10	100.7	2.85	.561	7	99.3	3.89	.981	8	104.6	4.41	1.399
19	98.6	2.17	.538	3	99.2	3.66	.525	31	102.4	4.42	1.258
3	96.7	2.59	.468	10	99.2	3.25	.847	13	100.5	5.57	1.210
8	96.0	2.41	.579	5	98.9	6.20	.989	1	100.4	6.64	1.358
24	95.5	2.47	.666	12	98.5	3.28	.861	15	100.3	1.91	0.920
7	95.1	2.08	.535	15	98.0	2.36	.676	2	100.3	8.71	2.324
14	94.5	1.95	.604	11	97.3	3.87	.816	11	100.0	4.19	1.228
11	93.6	2.31	.598	2	96.6	3.84	.983	34	100.0	0.93	1.302
2	93.4	2.85	.521	14	95.8	3.68	.938	3	99.7	5.19	0.902
23	93.3	1.63	.451	28	95.5	2.42	.652	7	99.6	4.24	0.931
5	93.2	2.57	.533	26	95.1	3.03	.820	14	97.1	3.84	2.114
20	92.7	1.89	.737	6	93.2	4.85	.682	4	95.3	5.28	1.122
16	91.7	1.61	.525	1	92.8	3.93	1.007	12	95.3	2.21	1.327
1	89.5	1.87	.688	13	92.5	1.42	.806	16	95.0	6.32	1.132
9	88.3	2.97	.568	25	91.9	3.44	.701	5	94.4	5.04	0.901
13	88.0	2.62	.669	27	90.4	2.30	.662	32	94.2	3.49	1.055
12	87.2	1.66	.790	9	86.5	4.31	.778	35	91.1	2.94	1.499
4	85.0	2.09	.579	16	82.7	1.67	.655	26	88.3	2.67	1.033
22	84.5	2.06	.561	4	80.5	1.13	.792	6	84.5	3.34	1.069
6	84.3	2.64	.580	18	78.7	3.45	.665	9	79.1	3.36	1.027
17	71.2	1.90	.465	17	69.4	4.14	.651	18	70.8	2.60	1.214
18	66.3	1.58	.487	30	46.2	1.93	.848	17	65.6	3.44	0.828
Mean	91.1	2.27	.119	Mean	91.4	3.34	.164	Mean	94.9	4.27	.267

On referring to Table 4 it is seen that there is a tendency for the "b" value to decrease in value as the "a" value decreases. The extent of the tendency is hidden by the variability of the "b" value. In order to reduce the variability, moving averages were taken of 7 of the "b" values and the corresponding "a" values. The resulting 18 pairs of values from each planting were plotted on cross section paper and a free hand curve fitted to the plotted data. The relationship was found to be curvilinear. From the fitted curves "b" values were read for certain given values of "a". These are presented in Table 5.



Table 5. - Reduction in Yield in Bushels per Acre per Borer per Plant ("b" value) of Certain Borer Free Acre Yields ("a" value) as Taken from a Curve Fitted to Data Derived from the Data Given in Table 4.

"a" Value	May 3 Planting "b" Value	May 17 Planting. "b" Value	May 31 Planting "b" Value
104	-----	-----	5.25
102	-----	4.15	-----
100	2.66	3.89	4.61
95	2.30	3.36	4.02
93	2.20	-----	-----
90	2.13	3.02	3.60
85	2.08	2.77	3.29
80	2.04	2.56	3.03
75	-----	2.40	-----

The values of "a" in Table 5 were so chosen that between any two successive values the relationship with the "b" values is approximately linear. Extrapolation beyond the values of "a" given in the table is also approximately linear within the limits of "a" values for the different strains given in Table 4.

As previously noted, the expected "b" value for hybrid A X TR averaged about 3.77 bushels for the three plantings, whereas the actual values averaged 2.34. From Tables 4 and 5 the expected "b" value for strain No. 15 (hybrid A X TR) is calculated to be 2.95 on the basis of its "a" value for the May 3 planting and to be 3.68 and 4.66 bushels for the May 17 and May 31 plantings. The actual values are 2.75, 2.36, and 1.91 for the three plantings, respectively. The mean of the actual values is 2.34 with a standard error of 0.412 whereas the mean of the three values calculated on the basis of the "a" value is 3.76 bushels. The difference between the means is 1.42. Since this difference is 3.45 times the standard error, 0.412, it is undoubtedly significant.

The Ohio strain No. 29 of the May 17 planting is the only other strain of importance showing a degree of tolerance. On the basis of its "a" value the "b" value is expected to be 4.53 whereas the actual value is 2.65. The difference of 1.88 is 2.2 times the standard error of 0.855, and is probably significant. Since this strain gave a high yield and was resistant to the borer it deserves further consideration. The double cross Ohio (356A x 584E) X (Ill.A x Ind.TR) should be tested for tolerance and resistance, since both single crosses give high yields, both show a degree of tolerance, and one is probably resistant with a pronounced tassel emergence characteristic somewhat similar to hybrid Hy X R4.





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